Volume : 2 | Issue : 11 | Nov 2013 • ISSN No 2277 - 8160

Research Paper | Engineering

A Distributed topology control technique for low interference And Energy Efficiency in Wireless Sensor Networks

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ABSTRACT

Topology control plays an important role in the design of wireless ad hoc and sensor networks; it is capable of constructing networks that have desirable characteristics such as sparser connectivity, lower transmission power, and a smaller node degree. In this research, a new distributed topology control technique is presented that enhances energy efficiency and reduces radio interference in wireless sensor networks. Each node in the network makes local decisions about its transmission power and the culmination of these local decisions produces a network topology that preserves global connectivity. Central to this topology control technique is the novel Smart Boundary Yao Gabriel Graph (SBYaoGG) and optimizations to ensure that all links in the network are symmetric and energy efficient. Simulation results are presented demonstrating the effectiveness of this new technique as compared to other approaches to topology control.

KEYWORDS : Graph theory, power control, proximity graphs,topology control, wireless sensor networks.

INTRODUCTION

Networks of sensors exist in many industrial applications pro-viding the ability to monitor and control the environment in real time. Most of these networks, however, are wired and as a result are costly to install and maintain. To lower the system and infrastructure costs wireless solutions can be used [2]. Wireless solutions have other benefits in industrial applications such as enhanced physical mobility, reduced danger of breaking cables,less hassle with connectors and ease of upgrading [3].

WSNs can be deployed in unpleasant, inaccessible or hazardous environments which are impractical with traditional wired networks such as in the bearings of motors or the inside of whirring motors [4]. In addition to this, the collaborative nature of WSNs brings about flexibility, self-organization,self-configuration, inherent intelligent-processing capability,and enables rapid deployment.

WSNs, therefore, are an attractive option for industrial applications. They are beginning to substitute the conventional industrial wired communication systems [5] in applications such as factory automation, distributed control systems, environment and equipment monitoring, product tracking, automotive systems and other kinds of networked embedded systems. WSNs play a crucial part in creating a highly reliable and self-healing industrial system that is highly responsive to real-time events with appropriate actions [6]. The data collected by sensor nodes is sent wirelessly to a sink node that analyses the data from each sensor node. Notifications of any possible problems can then be sent to plant personnel or instructions can be relayed back to the senor nodes to activate on board actuators in a certain way if equipped.

2. RELATED WORK

Different approaches to topology control will produce dif-ferent results. For a collection of nodes V, let G denote the graph on V for which there is an edge from node u to node v only if u can directly reach V. It is desirable to judge the usefulness of a Topology T returned by a topology control algorithm and compare it with results from other algorithms. In order to do this,some metrics and measures are required which include connectivity, energy efficiency, throughput, and robustness to mobility

[15].

1) Connectivity: If there is a multihop path between and in , then there should also be a path in . This is a basic requirement for a topology control algorithm, that it should not disconnect a connected graph.

2) Energy Efficiency: The energy consumed for a transmis-sion between and is a polynomial function of the distance between and . Two common notions of energy efficiency are the energy stretch factor and the hop stretch factor. The energy stretch factor is the worst increase in energy used to deliver a packet between any pair of nodes and along a minimum en-ergy path between the original graph and the topology con-trolled graph . The hop stretch is similar except that the focus is on path length as opposed to energy consumption. Formally,

$$\text{energy stretch factor} = \max_{u,v \in V} \frac{E_T(u,v)}{E_G(u,v)}$$

where is the energy consumed along the most energy-efficient path in graph . Likewise

$$\text{hop stretch factor} = \max_{u,v \in V} \frac{|(u,v)_T|}{|(u,v)_G|}$$

3) Node Degree: In order to better evaluate the performanceof the topology control technique in terms of interference, a distinction is made between the physical and the logical node degree. The physical node degree refers to the number of neighbor nodes that are within the transmitter range of a given node. The logical node degree refers to the number of neighbor nodes that a given node is linked to.

4) Simplicity and Maintainability: It is desirable for a topology to be simple and easy to maintain and objective measures that can be used to evaluate these subjective goals are the number of edges in and the maximum node degree (number of neighbors) of any node in . It is desirable also for the algorithm used to have little overhead in terms of computation and communication requirements.

5) Throughput: It is desirable for the network topology to have a high throughput, where it is possible to sustain a comparable amount of traffic as the original network topology .Several throughput measures can be used [15] one of which is the bit-meter which is defined in terms of the bit-distance product.A network transports one bit-meter when it one bit is transported a distance of one meter. The throughput of the network is then the number of bit-meters transported per second.

3) EXISTING SYSTEM

The predetermined network deployments provide a quick way of comparing the topology control algorithm with other well-known algo-

rithms and they help in visualizing how itworks. Situations in which it is well suited are also made apparent.

1) Double Ring Deployment: In the double ring deployment ,the nodes are evenly distributed on the perimeters of two concentric circles with different radii, with one node located at the centre. This deployment can show topology control algorithms that are not degree-bounded and the energy efficiency of different algorithms. The topologies produced for the Delaunay graph, ring network with 61 nodes are in performance metrics.

2) Exponential Node Chain Deployment: The exponential node deployment is a one in which the distance between nodes increases exponentially [22]. This network can be used to compare the interference of different topology control algorithms.
The topologies produced for the exponential node chain net-work with ten nodes by the Delaunay graph, the , the SBYaoGG and the MST respectively, are in the performance metrics.

3) Uniform Random Network Deployment:In order to characterize the performance of a topology control algorithm that encompasses all sorts of network deployments it is useful to evaluate the algorithms based on their performance in several uniform random networks. Topologies generated by different topology control algorithms, including the SBYaoGG for the same uniform random network.The results are obtained for several uniform random networks of different sizes.

4. PROPOSED SYSTEM

SMART BOUNDARY YAO GABRIEL GRAPH (SBYAOGG)

A. Objectives

There were two design objectives in developing the envis-aged topology control technique for WSNs. The first objective was that it should be energy efficient and the second was that it should have low interference. Performance measures were used to determine how well these objectives were met. The relative performance of the new technique compared to other well-known approaches to topology control was also used to evaluate how well these objectives were met.These objectives, however, are competing as improving energy efficiency, as measured through the energy stretch factorof a generated topology, increases the level of interference in the network as measured by the maximum and average node de-gree of the generated topology. In addition to this, topology con-trol involves a compromise between energy conservation and network connectivit.

5) CONCLUSION

In this research, a topology control technique for energy efficient and low interference in wireless sensor networks was developed in the form of the SBYaoGG algorithm. The SBYaoGG algorithm was evaluated using a simulation program and was shown to perform favorably. The SBYaoGG algorithm is a variation of the standard Yao Gabriel graph in which the boundaries of the regions of the Yao graph depend on the distribution of neighbors around a node. The average unit direction vector of the neighbors of a node is used as the axis of the first cone of the Yao graph. The SBYaoGG looks to develop as sparse a topology as possible with good power spanner properties. This is achieved by computing a Gabriel Graph from the original Unit Disk Graph and then computing the Yao Graph on the Gabriel Graph using smart region boundaries.

The performance of the SBYaoGG algorithm was evaluated using several performance metrics and compared with that of other topology control algorithms. The metrics that were chosen were those that measure energy efficiency, interference, and the routing efficiency that will be a result of using the topology controlled graph as input to a routing protocol.

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